Space Weather Technical Forecast

Issued on Wednesday, 31 July 2024 at 01:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: CME arrivals expected, most likely Day 1 (31 Jul), with G1-G2 Minor to Moderate storms and a chance of G3 Strong Storms. Ongoing M-class and X-class flare risk.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with at least four M-class flares observed, the largest being a M9.5 from AR3772 in the southeast at 30/1938UTC.

There are 12 sunspot regions, including five with delta configurations. This includes AR3768 in the southwest, which comprises of a series of penumbra surrounded spots, and has a clear delta spot to the north of one of its intermediates. AR3770 in the north-centre, persists as a compact region with a small but relatively strong delta spot to its north, and with some indications of further potential flux emergence. AR3765, AR3766 and AR3767 make up a cluster of spots just west of south-centre disc. AR3765 is the largest, containing a delta spot as part of its intermediate spots. AR3766, continues to maintain a delta spot and seen its leader elongate. AR3767 is a comparatively simpler region situated in very close proximity behind AR3765. A new small region is also emerging west of the main central cluster.

Newly numbered AR3772 on the far east limb may also have a small delta spot on its leader, although confidence is low due to the oblique viewing angle. This region is likely the anticipated source of the recent large far-sided events and has also been responsible for the recent M9.5 flare. The region has been given a preliminary analysis, however further complexity is likely to become apparent as it moves further onto the disc.

A number of CMEs were observed, however none from the past 24 hours have been assessed as having an Earth directed component.

Solar Wind / Geomagnetic Activity: The solar environment has been under waning CME influences over the last 24 hours due to a late CME arrival at L1 late on the 29th. Solar winds speeds, as measured by ACE at L1, initially increased to peak at around 500km/s at 30/0457 UTC, then showed a slow decline to finish the period at around 400 km/s. Density was initially just above average, before falling to around average from 30/1040UTC, then declining to below average by the end of the period. Interplanetary Magnetic Field, Bt, was initially strong, peaking at 18.2nT at 30/0200UTC. Levels slowly declined to be moderate for most of the period, before finishing at weak levels, around 6nT. The north-south component, Bz, was initially Moderately positive, peaking 13nT at 30/0113 UTC, but then switched to negative with minimum -12nT at 30/0209 UTC. An erratic weakening trend was then observed but with a general magnetic cloud type rotation from, 30/0530 UTC from negative to weak positive values. The resulting Geomagnetic activity was Active to G1 Minor Storm (Kp4-5) at first, with G1 observed 30/0300-0600 UTC, before falling to Quiet to unsettled (Kp1-3) from 30/1200 UTC.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at background throughout. High energy electron flux (greater than 2MeV) observed at GOES16 was also at background. The 24-hour fluence was below the Active threshold with 1.39e6 integrated pfu observed at 31/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is expected with further M-class flares expected and chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: A number of CMEs have the potential to arrival through the period. The CMEs from the M9.9 early on 28 Jul, and then the M2.6 and long period M1.7 later on 28 Jul are expected to combine to give a single arrival early on Day 1 (31 Jul). A further glancing CME arrival is then likely on Day 2 (01 Aug) from the M8.7 flare on 29 Jul. No coronal hole fast wind enhancements are expected, with CME arrivals expected to dominate, bringing spells of slightly elevated to elevated winds, and periods of Active to G1-G2 Minor to Moderate Storms. There is a chance of G3 intervals, mainly Day 1 (31 Jul).

Energetic Particles / Solar Radiation: High energy proton flux is currently at background. Should any notable flares occur there is a likelihood of this increasing above background, with a chance of exceeding the S1/Minor Storm threshold. This is due to the increasingly geoeffective location of the sunspot regions on the disc. The high energy electron flux is forecast to be mostly at background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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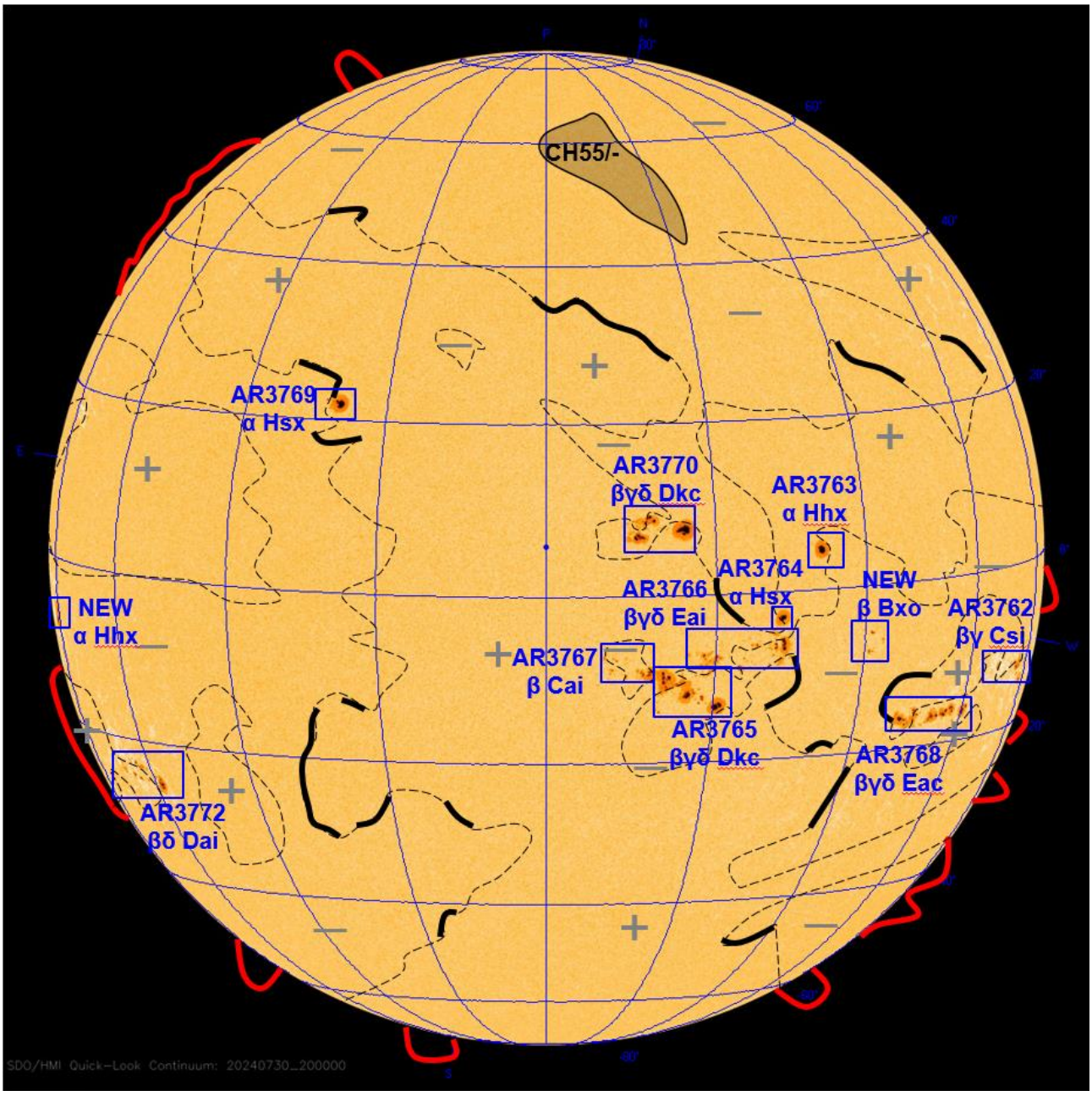
Figure 1. Solar Analysis Valid 30/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Current CME influence from the arrival on the 29th July is expected to ease, however there are further Earth-directed CMEs that are expected to arrive through this period.

The first is a halo CME from the M9.9 from AR3766 on 28/0200 UTC, but likely mainly shock with limited material. The second is a partial halo from the combination of the M2.6 at 28/1250UTC from AR3762 and the long duration M1.7 at 28/1422 UTC from AR3768, off the southwest disc. This second CME is faster than the first, with both likely combining to give a single arrival early on Day 1 (31 Jul). Timings are low confidence however, as both CMEs were non-trivial to assess due to contamination from other CME's occurring off the Earth-Sun line, and some poor imagery quality.

A further CME arrival is then possible on Days 2-3 (01-02 Aug), from the M8.7 flare at 29/1255 UTC from AR3762 and the dimming that occurred to the north of the region. This is low confidence, however with a glancing impact most likely. Furthermore, due to the number of coincident CMEs, including those off the Earth-Sun line, analysis has been more difficult than usual. Consequently further weaker arrivals also cannot be ruled out through the period.

No coronal hole fast wind enhancements are expected, with CME arrivals expected to dominate the next few days. These will bring periods of Active to G1-G2 Minor to Moderate Storms. There is a chance of G3 intervals, mainly Day 1 (31 Jul).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	70	50	25	5
Strong	G3	No	25	10	5	1
Severe	G4	No	5	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0808	Asymmetric Full	M9.9 AR3764	03W 04S	598 km/s	31/0300 -6/+12 hrs	Complex analysis Likely combined arrival with below
28/1838	Partial Halo	M2.6 AR3767 M1.7 AR3768	18W 08S	747 km/s	31/0300 -6/+12 hrs	As above
29/1832	Partial Halo	M8.7 AR3762	20W 37N	701 km/s	01/1400 +/- 12 hours	Low confidence

Radio Blackouts - X-Ray Flares:

High to Moderate activity is forecast, with M-class flares expected and a chance of further isolated X-

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class flares.

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Newly numbered AR3772 on the far east limb may also have a small delta spot on its leader, although confidence is low due to the oblique viewing angle. This region is likely the anticipated source of the recent large far-sided events and has been responsible for the recent M9.5 flare. This has been given a preliminary analysis, however further complexity is likely to become apparent as it moves further onto the disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	90	90	90	90
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 2: GOES18/16 previous 24 hour X-ray Flux

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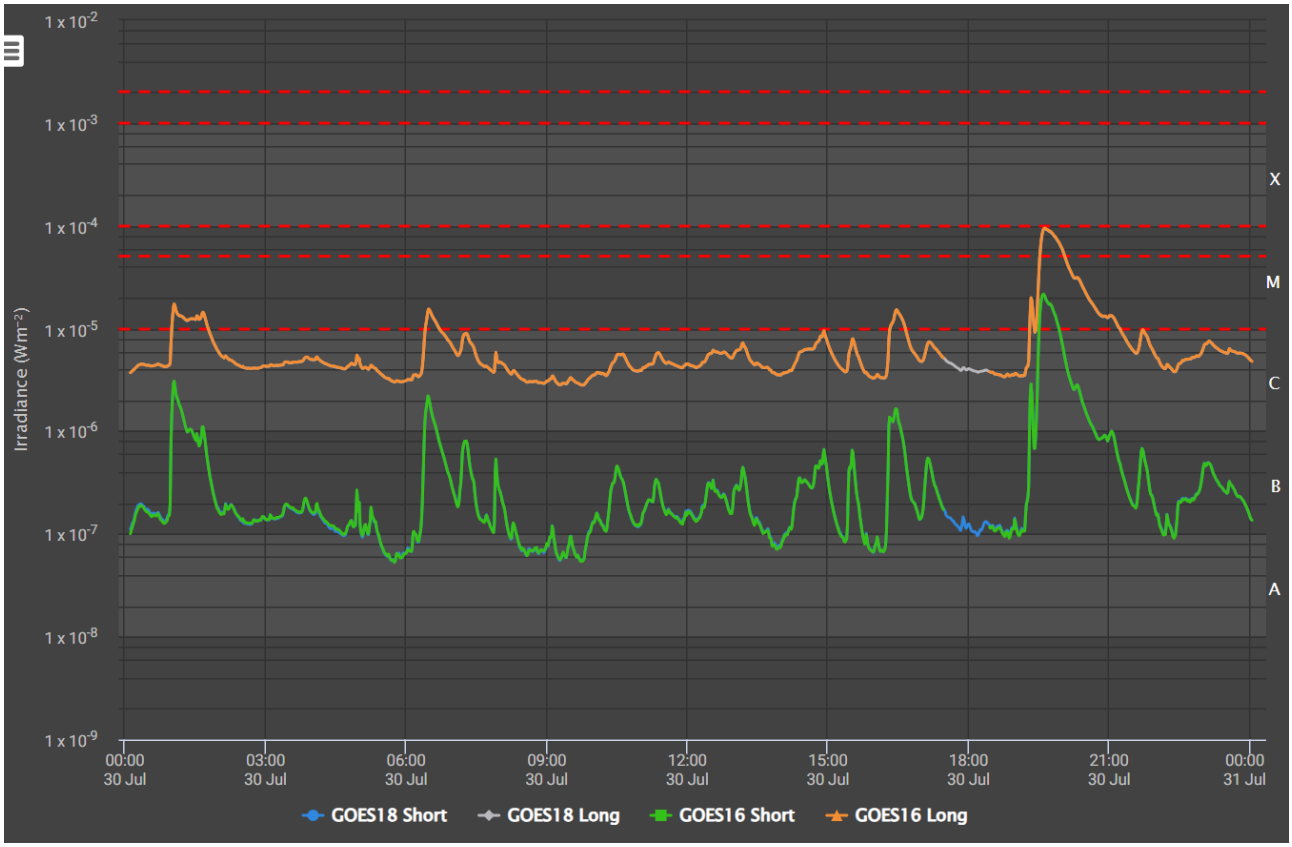

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Solar Radiation Storms - (High Energy Protons):

High energy proton flux, as observed by GOES-18 is currently is currently at background but has the potential to see small rises in response to any notable flares on the disc, with a number of moderately sized and complex sunspots moving into the western hemisphere. This brings a chance of reaching the S1 Minor Radiation Storm level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	25	25	25	25
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16, is currently at background levels after being suppressed by the CME arrival late on 29 July. Further CME arrivals are anticipated to keep the observed flux at background, but may allow for a re-enhancement once any CME influence recedes, with Moderate flux possible Day 3-4 (02-03 Aug).
The associated 24 hr electron fluence is expected to remain below Active. MOSWOC REFM is currently providing a reasonable guide, but confidence in this becomes Low with any further CME arrival on 31 Jul.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	5
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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